Space Weather Technical Forecast

Issued on Sunday, 31 March 2024 at 00:47 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-flares likely from AR3615 (R1-R2 Blackouts) with slight chance of X-flares (R3 Blackouts). Risk decreases through Day 2 (01 Apr).

Analysis of Space Weather Activity over past 24 hour

Solar Activity: Activity has been Moderate with a long duration M-flare peaking at M9.4 at 30/2116 UTC from AR3615. There are currently six sunspot regions on the visible disc, most of which are small and simple. AR3615 is the largest and most complex region on the disc, although the leading portion has now rotated beyond the western limb. Due to the restricted viewing angle the previous classification has been retained. A delta region can still be seen on the rear portion of the group.

There have been a number of CMEs observed in coronagraph imagery over the past 24 hours, none of which were analysed to have an Earth-directed component. Two filament disruptions occurred around 30/2300 UTC, one from the northeast and one close to centre disc, these and are yet to be analysed.

Solar Wind / Geomagnetic Activity: The solar wind measured by DSCOVR at L1 started the period at slow-ambient levels (around 330 km/s), before increasing from around 30/1300 UTC with the onset of an incoming high speed stream from CH15/+. Wind speeds showed a steeper increase from 30/1729 UTC becoming Slightly Elevated at 30/1847 UTC and are currently around 440 km/s. Density rose to average around 30/0500 UTC, where it has largely remained with a brief window of above average, peaking at 18ppcc at 30/1205 UTC. Interplanetary Magnetic Field, Bt, has been on an increasing trend, rising to Moderate around 30/1300 UTC with a peak of 14nT at 30/2039 UTC. The north-south component, Bz, fluctuated moderately between +8nT/-9nT but largely remained positive until 30/2300 UTC. The phi angle has remained mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) remained mostly at background and well below the S1/Minor Radiation Storm level. High energy electron flux (greater than 2MeV) observed at GOES16 has been background with a diurnal peak at moderate levels. The associated 24-hour fluence remained below Active, with a value of 1.20e7 integrated pfu at 31/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity at first, with a slight chance of an isolated X-flare from AR3615 as it continues to rotate across the southwest limb. This region is expected to depart the disc later Day 1 (31 Mar) with flare risks reducing significantly. However, any notable Strong flares may remain observable into Day 3 (01 Apr). Then activity is expected to be Low.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs expected during the forecast period. Solar wind are exhibiting signs of enhancement from a HSS From CH15/+, winds are expected to remain at Slightly Elevated levels Days 1-2 (31 Mar-01 Apr), perhaps peaking at Elevated levels before easing later Day 2 and Day 3 (02 Apr). The arrival of further fast winds associated with CH16/- and CH17/- may see winds return to Slightly Elevated or Elevated levels later Day 3, or more probably into Day 4 (03 Apr).

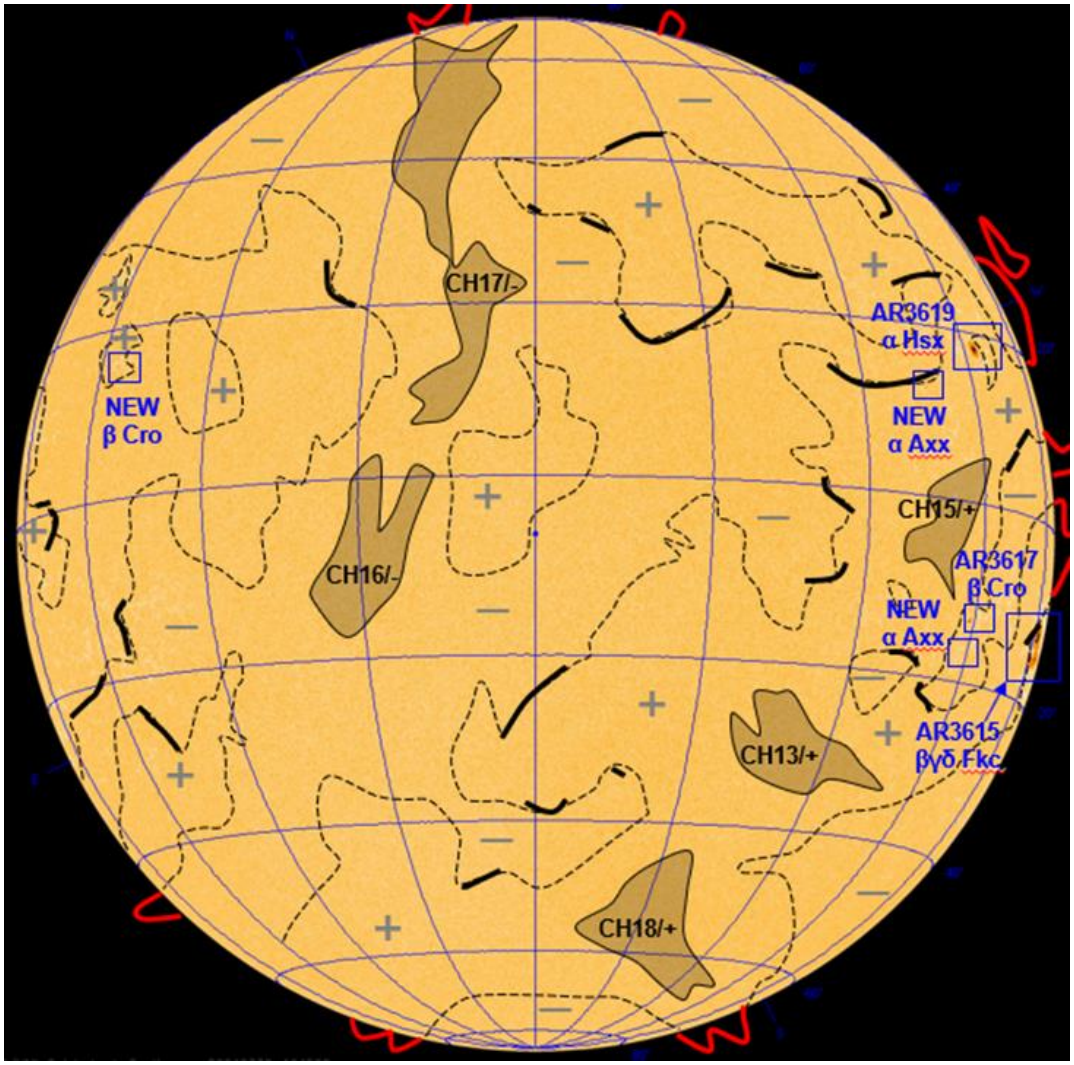
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) but with a chance of Unsettled (Kp 3) or Active (Kp 4) intervals Day 1 and again from later Day 3 (02 Apr).

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES18, is expected to be near background levels, but with a slight chance of a further enhancement above the S1 level given any strong flares from AR3615 until Day 3 (02 Apr). High energy electrons are likely to continue at Low to Moderate levels, with only a slight chance of reaching High. The associated 24 hour fluence may exhibit a slight increasing trend initially but is expected to remain well below the Active threshold. Any enhancement from connection to coronal hole fast winds is not expected to present in observed flux or fluence values during the period.

Figure 1. Solar Analysis Valid 30/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms:

At present, there are no Earth-directed CMEs expected during the forecast period. However, there are two filament eruptions that are yet to be analysed.
The analyses of CMEs that left the Sun in recent days by MOSWOC Enlil supports this, although there are a few ensemble members that suggest there may be a glancing blow later Day 3 or Day 4 (02-03 Apr).

Solar wind speeds are currently at Slightly Elevated levels, around 470 km/s following the onset of a HSS from CH15/+. Wind speeds may increase further through Day 1 to Elevated levels, with an additional contribution possible from a HSS from CH13/+. These are small, non-recurrent features and are not favoured for a geomagnetic response at this time of year due to their positive polarity. MOSWOC Enlil is too slow with the onset of the HSS, although wind speeds are considered reasonable. Wind speeds are likely to ease later Day 2 (01 Apr).
Further high speed streams from coronal holes CH16/- and CH17/- may arrive at Earth by the end of the period as signalled in Enlil. These features appear larger and stronger than on the last rotation, and their negative polarity may produce a more appreciable geomagnetic response. Speeds of 450-550 km/s possible.

Geomagnetic activity is expected to be mainly Quiet (Kp 0-2) but with a chance of Unsettled or Active intervals Day 1 and again from later Day 3 (02 Apr).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

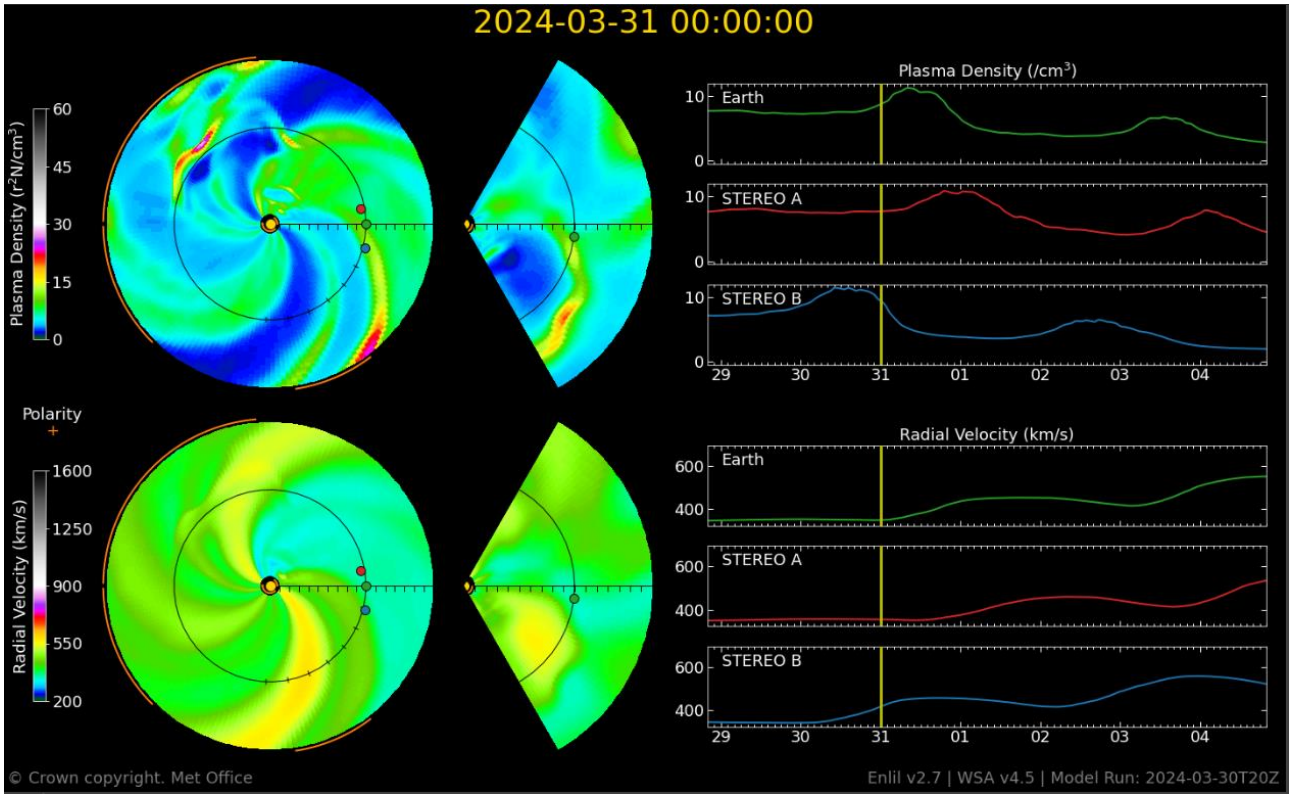
Geomagnetic Activity - Earthbound Coronal Mass Ejections

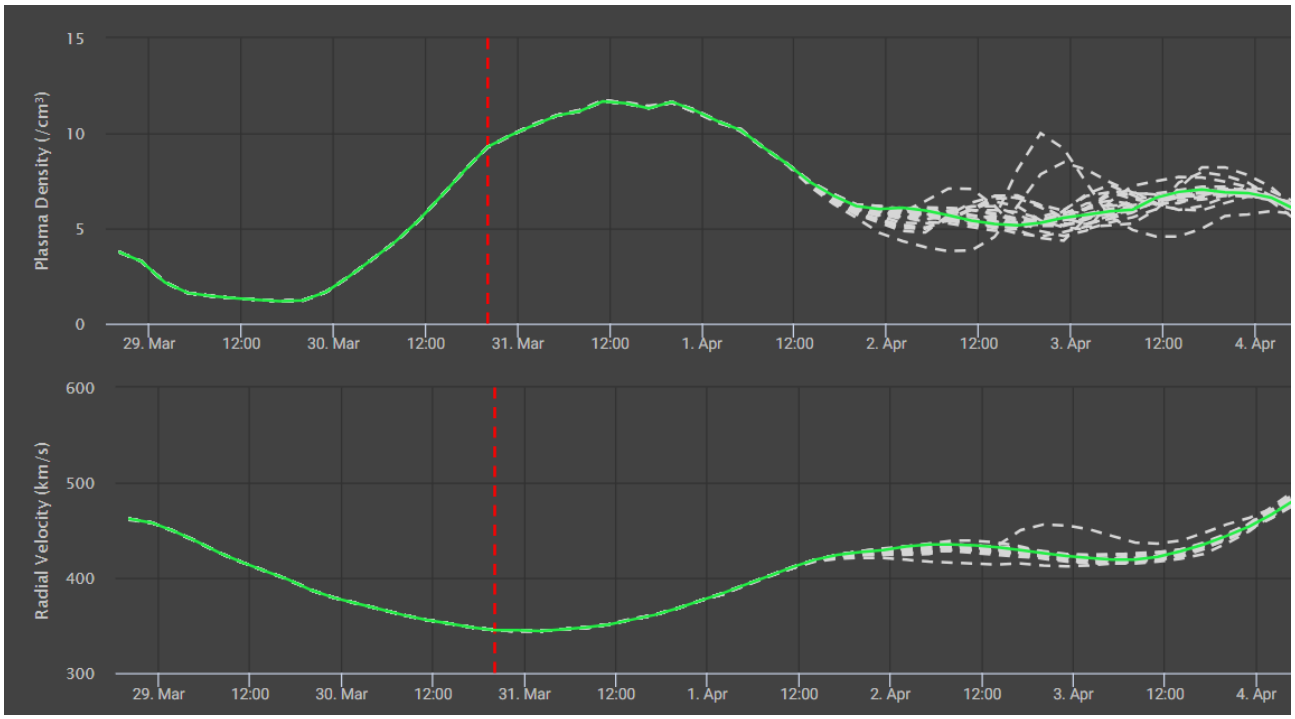
No Earth-directed CMEs currently expected.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 2: MOSWOC Enlil and Enlil Ensemble. Currently thought to be giving good guidance although onset of HSS from CH15/+ was earlier than forecast.





Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

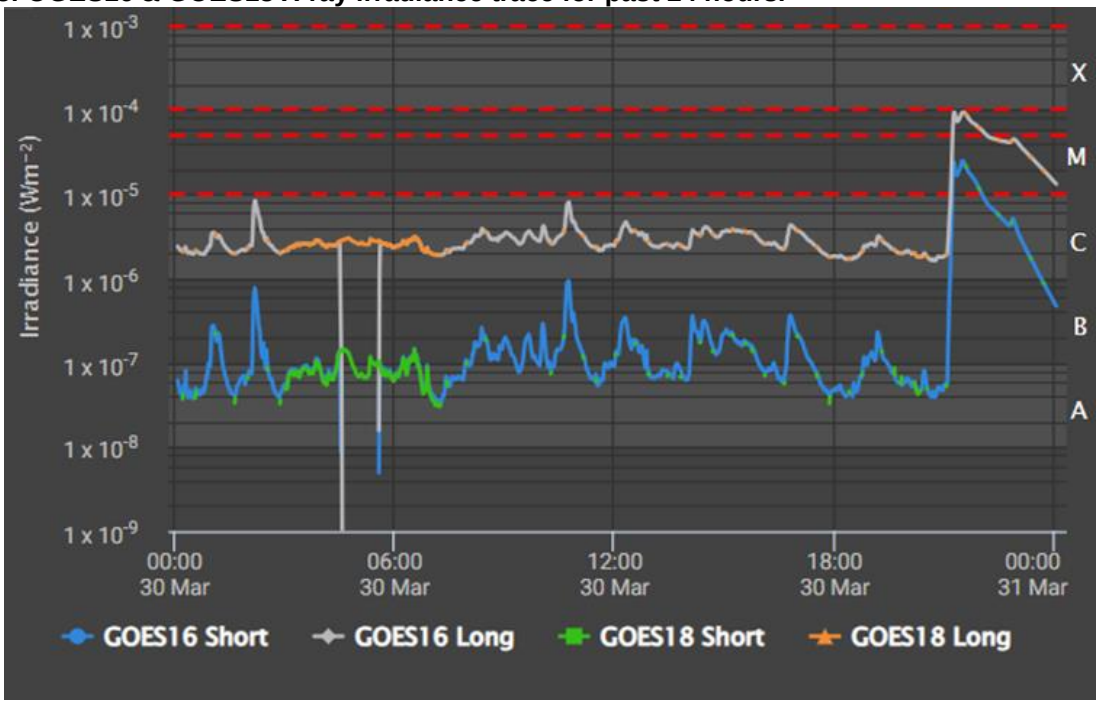
© Crown Copyright 2024. All Rights Reserved.

Radio Blackouts - X-Ray Flares:
Moderate activity is expected Day 1 (31 Mar), with a slight chance of an isolated X-flare from AR3615 as it continues to rotate across the southwest limb. As the region rotates away over the limb, the risk gradually reduces, but with a risk of any large flares being observable until later Day 2 (01 Apr). Activity is then expected to be Low.

AR3615 (Fkc/Beta-Gamma-Delta) dominates the flare forecast, remaining a very large and relatively complex sunspot group. Due to the restricted viewing angle of the group as it approaches the western limb, the previous analysis has been retained, but at least one delta spot remains evident. The other spots are all small and simple regions, unlikely to be sources of notable flare activity. All but one of these regions lie close to the western limb.
Far-sided seismic imagery suggests that a new or returning region may emerge onto the solar disc during Day 4 (03 Apr). Flare probabilities have been maintained through Days 3-4 (02-03 Apr) to allow for the possible emergence of these, or other regions that may develop on the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	30	20	20
Very Active	R3 to R5 X Class	No	20	5	1	1

Figure 3: OGES16 & GOES18 X-ray irradiance trace for past 24 hours.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

High energy proton flux observed by GOES-18 is now at or very slightly above background levels again after the S2/Moderate Radiation storm that peaked 24 Mar. Further large flares from the departing AR3615, especially more intense or longer duration ones, could still be eruptive and proton rich. The associated risk of proton events is maintained until the region has rotated fully beyond the west limb, declining by Day 3 (02 Apr).

There is a slight chance of reaching the S1/Minor Radiation Storm threshold Days 1-2 (31 Mar-01 Apr), given any further significant flaring from this region.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	5	5
Very Active	**≥ S3 ***	No	5	5	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 at GEO, has remained at background levels, with a diurnal peak at Moderate. Any fast wind connection to coronal holes CH15/+ and CH13/+ is expected to be minimal, and is not expected to increase the risk of prolonged High flux levels. Later in the period, the connection to coronal holes CH16/- and CH17/- may produce a greater effect on flux levels, however any increase to High is not expected during the forecast period.

The associated 24 hour electron fluence is expected to remain well below the Active level, although a slight rising trend is possible and signalled by REFM. Suppression of fluence levels is possible from later Day 3 or Day 4 (02-03 Apr) due to the expected arrival of, and connection to, fast winds from coronal holes CH16/- and CH17/-. Although fluence levels are currently above REFM forecast levels, REFM is still considered to be giving good guidance for the overall trend.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 4: GOES16 Electron trace over past 24 hours.

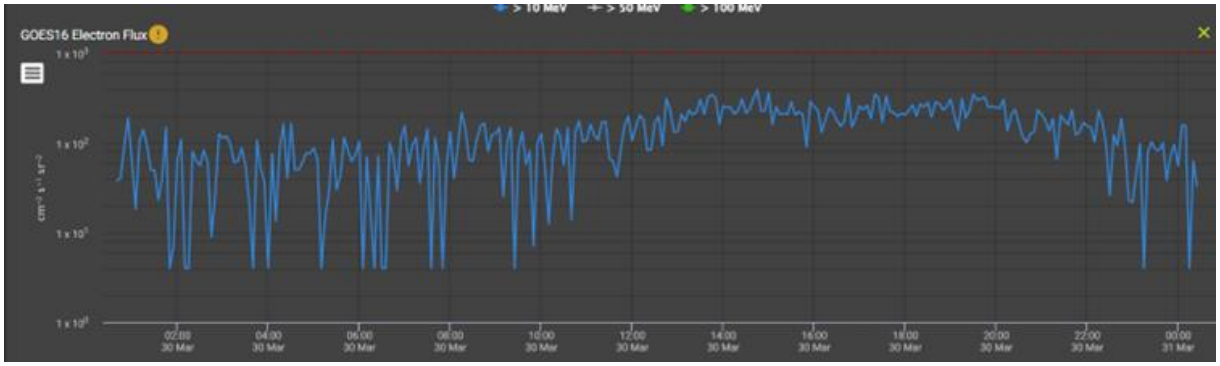
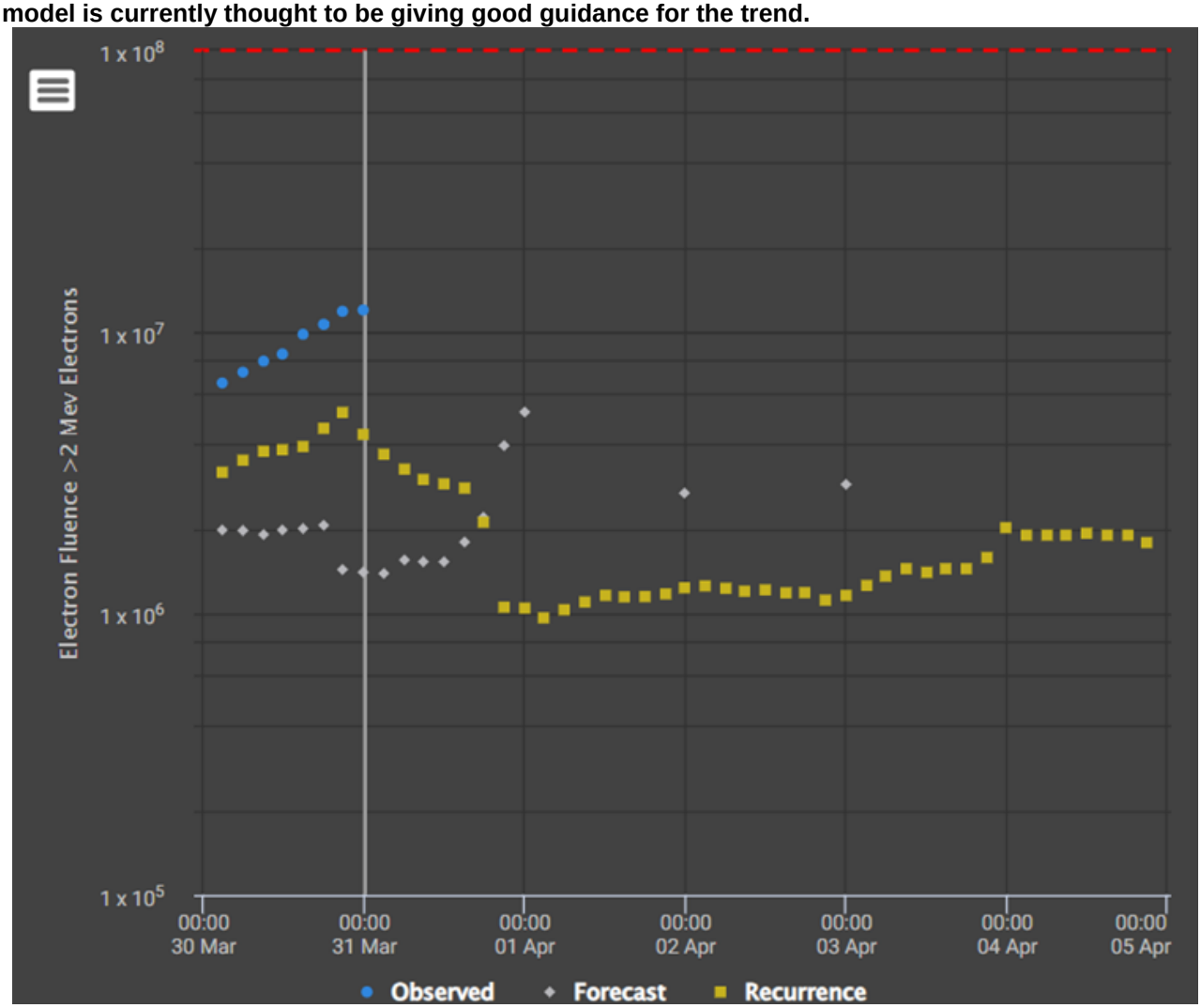


Figure 5: MOSWOC REFM. Although forecast values are lower than those currently observed, the model is currently thought to be giving good guidance for the trend.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.